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PATENT ABSTRACTS OF JAPAN

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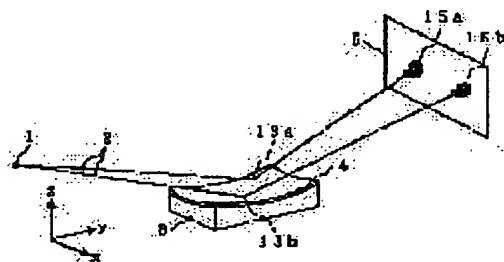
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(54) X-RAY REFLECTOR AND X-RAY REFLECTION OPTICAL SYSTEM

(57)Abstract:

PROBLEM TO BE SOLVED: To produce X-ray beam whose intensity distribution is constant.

SOLUTION: The X-ray 2 radiated from a light source 1 is reflected by a reflector 3 and projected on an exposure surface 5. The reflector 3 is constituted of SiC and Pt film 4 is formed on the surface. In X-ray intensity distribution on the exposure surface 5, an uneven condition exists that the intensity of an area 15a which the X-ray from a reflection point 13a reaches is high and an area 15a which the X-ray from a reflection point 13b reaches is low. Elimination of the uneven condition in such a case requires lowering the reflectance of the reflection point 13a. Lowering the reflectance is conducted by masking the section of the reflection point 13a for exposure of SiC at the time of forming the Pt film 4 on the surface of the reflector 3.



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CLAIMS

[Claim(s)]

[Claim 1] The aforementioned reflector is an X-ray reflecting mirror characterized by being what has the field where the reflection factor of an X-ray is high in the X-ray reflecting mirror which condenses the X-ray emitted from X line source to a predetermined field by the reflex on a reflector, and the field where the reflection factor of an X-ray is low.

[Claim 2] The field where the reflection factor of the aforementioned X-ray is low is an X-ray reflecting mirror characterized by being the field in which the matter with the reflection factor of an X-ray the field where the reflection factor of the aforementioned X-ray is high is a field in which the matter with the high reflection factor of an X-ray was formed in an X-ray reflecting mirror according to claim 1, and low was formed.

[Claim 3] The field where the reflection factor of the aforementioned X-ray is low is an X-ray reflecting mirror with which the surface roughness of the field where the reflection factor of the aforementioned X-ray is high is a parvus field in an X-ray reflecting mirror according to claim 1, and it is characterized by a surface roughness being a large field.

[Claim 4] In the X-ray catoptric system which projects the X-ray emitted from X line source on an exposure side by reflex The X-ray reflecting mirror which reflects the X-ray emitted from X line source, and condenses to an exposure side, In order that a position on-the-strength detection means to detect the intensity distribution of the X-ray which it is arranged in the aforementioned exposure side and irradiated by the exposure side, and the X-ray intensity on an exposure side may reduce the X-ray reflection factor of the reflective field of the X-ray reflecting mirror which corresponds with a strong position X-ray catoptric system characterized by having the generator which generates the ion or neutral particle for irradiating the aforementioned reflective field.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[The technical field to which invention belongs] In the X-ray lithography using synchrotron radiation (Synchrotron Radiation:SR) etc., this invention condenses or expands the X-ray emitted from the light source, and relates to the X-ray reflecting mirror and X-ray catoptric system which are used in order to project on an aligner efficiently.

[0002]

[Description of the Prior Art] X-ray lithography forms the detailed pattern of a VLSI using an X-ray, and since wavelength is short, it is the technique 0.1 smaller than the wavelength of the light microns or less which even a detailed pattern can overly imprint. The X-ray optics system which introduces into an X-ray aligner X line source which generates an X-ray, the X-ray aligner which imprints a detailed pattern using an X-ray, and the X-ray further emitted from X line source is required for X-ray lithography. However, since there is still no X line source with high directivity like laser now, only X line source which is emitted from a line source exists. Therefore, in order to irradiate a powerful X-ray beam at an X-ray aligner, the X-ray optics system which condenses the X-ray which emits is indispensable. An X-ray reflecting mirror is used in such optical system.

[0003] In the conventional X-ray catoptric system, the reflecting mirror which has the configuration described by polynomials, such as a toroidal side which combined the spherical surface, paraboloid of revolution, a spheroid, or the different spherical surface of curvature, is used for the X-ray reflecting mirror which condenses an X-ray. Moreover, the X-ray optics system which combined some reflecting mirrors of these configurations is also used in order to bring an X-ray together in a specific exposure field efficiently. If the front face of the electromagnetic wave of the matter is smooth, it will be reflected with a high reflection factor. In order to reflect the X-ray with wavelength short among electromagnetic waves, the surface smoothness needs for irregularity to be as small as the same size as an atom. Furthermore, in order to reflect an X-ray, you have to use the total reflection phenomenon which produces the angle which the X-ray which carries out incidence to a reflector accomplishes by making it the low angle of 1 time or 2 times or less. It becomes important that an incident angle improves not only surface irregularity but flatness for a parvus reason. It does not deform for high rigidity, but since thermal conductivity is high, the material which deformation by heat does not have, either is used now, flatness is high and the development of the X-ray reflecting mirror with a very smooth front face is furthered.

[0004] In order to make the attempt which uses X-ray lithography for super-LSI manufacturing process in semiconductor industry and to be realized industrially recently, the enhancement in exposure luminous efficacy is indispensable. Exposure luminous efficacy has the strong intensity of the X-ray when exposing, and becomes so high that the exposure area per [which is 1 time] exposure is large. Furthermore, in the field to expose, in order to maintain the quality of exposure, the X-ray intensity in a field must be fixed. Therefore, an intensity is strong in a big area to enhancement in exposure luminous efficacy, and X-ray beam formation with strong high homogeneity is made indispensable.

[0005]

[Problem(s) to be Solved by the Invention] In order to raise exposure luminous efficacy in X-ray lithography, an intensity is strong and formation of the X-ray beam with high on-the-strength homogeneity is indispensable. In order to raise an intensity, the optical system with big opening which can incorporate many [as possible] X-rays which emit is required. On the other hand, if strong homogeneity is made into the system which incorporates many [as possible] X-rays, it will tend to become low. In order for this to correspond to shutting up in a fixed field and to stuff by force the X-ray with which operation of condensing spreads, it is because the roughness and fineness of an X-ray beam are made to a condensing field. The homogeneity of X-ray intensity which X-ray lithography needs is 4% or less, and even if the roughness and fineness of few beams exist, it cannot be attained. In the conventional X-ray catoptric system, there was a trouble where high intensity and X-ray irradiation of high homogeneity were not made, as mentioned above. this invention aims at offering the X-ray reflecting mirror and X-ray catoptric system which make an X-ray beam whose intensity distribution of an X-ray are fixed in the field required in order to use X-ray lithography in semiconductor industry which condensed.

[0006]

[Means for Solving the Problem] this invention is made to have the field where the reflection factor of an X-ray is [the above-mentioned reflector] high, and the field where the reflection factor of an X-ray is low in the X-ray reflecting mirror which condenses the X-ray according to claim 1 emitted from X line source to a predetermined field by the reflex on a reflector like. In the X-ray catoptric system which condenses the X-ray emitted from X line source with a reflecting mirror, an X-ray is reflected with the reflection factor corresponding to the incident angle on the front face of a reflecting mirror. A reflection factor is expressed by the formula of a fresnel and influenced by the granularity corresponding to the modality of matter and the irregularity of a reflector which constitute a reflector. Then, since the X-ray from this field declines by reducing the reflection factor of the surface field of a reflecting mirror in which the X-ray is reflecting the X-ray which arrives at a too strong field in the condensing field, the intensity distribution of the X-ray in a condensing field can be made regularity.

[0007] Moreover, the field where the reflection factor of the above-mentioned X-ray is high is a field according to claim 2 in which the matter with the high reflection factor of an X-ray was formed like, and the field where the reflection factor of the above-mentioned X-ray is low is a field in which the matter with the low reflection factor of an X-ray was formed. Moreover, like, the surface roughness of the field where the reflection factor of the above-mentioned X-ray is high is a parvus field, and the field where the reflection factor of the above-mentioned X-ray is low is a field according to claim 3 where a surface roughness is large. Moreover, the X-ray according to claim 4 emitted from X line source is set like to the X-ray catoptric system projected on an exposure side by reflex. The X-ray reflecting mirror which reflects the X-ray emitted from X line source, and condenses to an exposure side, In order that a position on-the-strength detection means to detect the intensity distribution of the X-ray which it is arranged in an exposure side and irradiated by the exposure side, and the X-ray intensity on an exposure side may reduce the X-ray reflection factor of the reflective field of the X-ray reflecting mirror which corresponds with a strong position It has the generator which generates the ion or neutral particle for irradiating the aforementioned reflective field.

[0008]

[Embodiments of the Invention]

1. of the gestalt of operation, next the gestalt of operation of this invention are explained in detail with reference to a drawing. Drawing 1 is a block diagram of the X-ray catoptric system used as the gestalt of operation of the 1st of this invention. It is reflected at each reflecting points 13a and 13b of the front face of the X-ray reflecting mirror 3, and X-ray 2 which emits from the light source 1 arrives at the fields 15a and 15b on the exposure side 5. A reflecting mirror 3 consists of a silicon carbide (SiC), and the Pt layer 4 is formed in the front face.

[0009] In such X-ray catoptric system, if the position of the light source 1, the position of a reflecting mirror 3, the position of the exposure side 5, the configuration of a reflecting mirror 3, and the incident

angle X-ray 2 carries out [an incident angle] incidence to a reflecting mirror 3 are decided, it will be decided that an of-condensation-and-rarefaction distribution of the X-ray irradiated by the exposure side 5 will be a meaning. Generally, by the of-condensation-and-rarefaction distribution by a difference of a reflection factor and distribution of a reflecting point, an X-ray intensity distribution is not fixed and 10% or more of strength exists in a strong fraction and a weak fraction.

[0010] Now, in the X-ray intensity distribution on the exposure side 5, the intensity of field 15a which the X-ray from reflecting point 13a reaches is large, and the intensity of field 15b which the X-ray from reflecting point 13b reaches assumes that the ununiformity of X-ray intensity called the parvus exists. What is necessary is just to reduce the reflection factor of reflecting point 13a of the reflecting mirror 3 corresponding to field 15a with a strong X-ray, in order to abolish such an ununiformity. Thereby, the X-ray intensity distribution on the exposure side 5 can be carried out to regularity.

[0011] Next, the technique to which the reflection factor of the X-ray reflecting mirror 3 is reduced locally is explained. X-ray 2 emitted from the light source 1 is reflected with the reflection factor corresponding to the incident angle on the front face of a reflecting mirror 3. A reflection factor is expressed by the formula of a fresnel and influenced with the modality of matter and the irregularity of a reflector which constitute a reflector. For example, when the matter which constitutes a reflector is heavy metal, such as Pt, Au, W, Ta, U, Pd, and Ru, a reflection factor is high, and a reflection factor is low when it is light matter, such as C, Si, and aluminum.

[0012] The relation between the incident angle of an X-ray in case the matter which constitutes a reflector is Pt and SiC, and a reflection factor is shown in drawing 2 and the drawing 3. As an X-ray which irradiates a reflector, the X-ray with a wavelength [which is used by X-ray lithography] of 0.6-0.9nm was used. When the wavelength of an X-ray of drawing 2 (a) is 0.6nm, the wavelength of drawing 2 (b) is 0.7nm and the wavelength of drawing 3 (a) is 0.8nm, drawing 3 (b) is the case where wavelength is 0.9nm.

[0013] When an incident angle in case an X-ray carries out incidence to Pt or SiC is 1.5 degrees or more, SiC hardly reflects an X-ray to Pt showing a high reflection factor. Therefore, when the field which consists of heavy metal, such as Pt, and the field which consists of light elements, such as SiC, are in a reflector, the intensities of the X-ray reflected differ.

[0014] What is necessary is just to expose SiC in the position of reflecting point 13a, in order to reduce the reflection factor of reflecting point 13a of the reflecting mirror 3 corresponding to field 15a with a strong X-ray from the above thing. Thereby, since a reflection factor falls and most X-rays are not reflected, the X-ray intensity of the position of field 15a becomes small.

[0015] Next, the X-ray intensity distribution on the exposure side 5 is actually calculated, and it examines of which field on a reflector an X-ray reflection factor should be changed. Here, space coordinatess x, y, and z shall be taken as shown in drawing 1. That is, the orientation of [from the light source 1] the exposure side 5 is y shaft orientations, and the upward height orientation perpendicular to this is z shaft orientations, it is perpendicular to y and z, and when rotating the y-axis to the direction of the z-axis clockwise, the orientation to which a right screw goes is x shaft orientations.

[0016] The light source 1 was used as SR light source which emits synchrotron radiation (it abbreviates to SR Synchrotron Radiation and the following), and the breadth of this SR light source was assumed to be a normal distribution with variance with a standard deviation of 0.8mm. And distance of 2760mm, and the center of a reflecting mirror 3 and the exposure side 5 is set to 6340mm for the distance of the light source 1 and the center of a reflecting mirror 3. Moreover, a reflecting mirror 3 shall have the configuration which can be written by the following formula.

[0017]

$$z = 9.22079702752712 \times 10^{-6} + 0.00427080057574197 + 8.28115405993602 \times 10^{-8} x^4 \\ + 5.014815819129886 \times 10^{-12} x^6 - 7.389003736146092 \times 10^{-6} y - 6.175952366769869 \times 10^{-7} x^2 y - \\ 5.244035396540827 \times 10^{-11} x^4 y + 3.532448535214485 \times 10^{-6} y^2 + 2.703327315869953 \times 10^{-10} x^2 y^2 - \\ 4.432466606511452 \times 10^{-10} y^3 + 1.083541174146448 \times 10^{-13} y^4 \dots (1)$$

[0018] Thereby, a formula (1) understands that a reflecting mirror 3 is a non-plane mirror of a complicated configuration more than including the 3rd term, x, y, and z. And an incident angle in case

X-ray 2 carries out incidence to the center ($x=y=z=0$) of a reflecting mirror 3 is made into 1.58 degrees. In the above X-ray catoptric system, it assumes that 2 Manmoto's SR occurred from the light source 1, and the intensity distribution which SR forms on the exposure side 5 are calculated.

[0019] The configuration of SR light source is shown in drawing 4, and the intersection of SR emitted from this SR light source 1 and the reflector of a reflecting mirror 3 is shown in drawing 5. And the whole intersection group configuration which SR reflected by the reflecting mirror 3 forms on the exposure side 5 turns into the shape of a straight line as shown in drawing 6. Then, a calculation of the density of the X-ray on the exposure side 5 obtains a contour-line distribution as shown in drawing 7 (a). For what integrated with this distribution to z shaft orientations, this is equivalent to an X-ray intensity distribution in drawing 7 (b). When asking for an intensity, it integrated with the spectrum of the X-ray of a between with a wavelength of 0.5-1.5nm.

[0020] From drawing 7 (b), since the intensity distribution of this optical system have the strong fraction of the oblique line, they understand that X-ray intensity is not fixed in an exposure field. In addition, it is because the beam-of-light density generated from the light source 1 varies that the point varies, it is increasing the number of beams of light, and dispersion decreases.

[0021] Subsequently, it examines whether the X-ray intensity on the exposure side 5 becomes uniform by changing the X-ray reflection factor of which field. First, the reflector of a reflecting mirror 3 is divided into 13 fields parallel to x shaft as shown in drawing 8. And suppose that each field is called by the identifier of a class. The X-ray intensity distribution which integrated with high line distributions, such as roughness and fineness which the X-ray reflected from each field on a reflecting mirror 3 makes on the exposure side 5, and this to z shaft orientations is shown in drawing 9 - view 20.

[0022] In addition, since it is so weak that the X-ray reflected from classes 31 and 43 can be disregarded, it shows only an of-condensation-and-rarefaction distribution in drawing 9 about a class 31, and has not written it about a class 43. As shown in drawing 9 - view 13, the X-ray reflected from the classes 31-35 of a reflecting mirror 3 arrives at the core ($x=0$ neighborhood) of the exposure side 5, and forms a distribution. On the other hand, as shown in drawing 14 - view 20, the X-ray reflected from classes 36-43 reaches the circumference section ($x=10$ and -10 neighborhood) of the exposure side 5, and forms a distribution.

[0023] It turns out that the rate to which the circumference section is strong to the core in the intensity distribution (drawing 17 (b)) of the X-ray reflected from the class 39 among the X-ray intensity distributions by the reflex from each class is [the circumference section] mostly equivalent to the rate which is strong to a core by the X-ray intensity distribution of the whole drawing 7 (b). Then, if it is made the structure in which the Pt layer 4 was not formed in the front face of the class 39 of a reflecting mirror 3, but SiC was exposed, as shown in drawing 21, it will hardly be reflected and an X-ray will consist of a class 39.

[0024] Thereby, the circumference section becomes low and the whole X-ray intensity distribution understands that a fixed intensity is obtained, as shown in drawing 22. What is necessary is just to carry out the mask of the fraction corresponding to a class 39, in case the Pt layer 4 is formed in the front face of a reflecting mirror 3, in order to expose SiC on the front face of a reflecting mirror 3.

[0025] In this way, according to the gestalt of this operation, the X-ray intensity on the exposure side 5 can realize the reflecting mirror 3 with the fixed X-ray intensity on the exposure side 5 only by carrying out the mask of the class of the reflecting mirror [in the case of reflecting mirror production] 3 to a strong position.

[0026] Although the technique of exposing SiC which is the quality of the material of a reflecting mirror 3 as technique of reducing the reflection factor of the class 39 of a reflecting mirror 3 was taken in 1 of the gestalt of 2. operation of the gestalt of operation, the gestalt of this operation realizes a fall of a reflection factor by forming the Pt layer 4 thickly.

[0027] A reflection factor is influenced as mentioned above by the granularity corresponding to the irregularity of the front face of the matter which constitutes a reflector. The case where a reflection factor declines in the type where surface-roughness sigma is described by the following formula is shown in drawing 23.

[0028]

[Equation 1]

$$e^{-(4\pi\sigma\sin\theta/\lambda)^2} \quad \dots (2)$$

[0029] Wavelength lambda of an X-ray is 0.7nm, and incident angle theta in which an X-ray carries out incidence to a reflector could be 1.58 degrees. Even if the front face is being worn all over Pt, it turns out that surface-roughness sigma arises by rms granularity, and big differentiation arises in a reflection factor by the case of 0, and the case 2nm or more. If surface-roughness sigma becomes larger than 3nm, most X-rays will not be reflected. Then, with the gestalt of this operation, the reflection factor of a reflecting mirror 3 is locally changed by forming the Pt layer 4 thickly.

[0030] Change of the surface roughness of Pt layer to a thickness is shown in [drawing 24](#). Formation of Pt layer was performed by the vacuum deposition method. In order to use it as a reflective layer, 7-10nm of the thickness of Pt layer is required, the thickness distribution at the time of layer formation is also taken into consideration in fact, and Pt is formed by the 10-20nm thickness. The surface granularity to a 10nm thickness is about 0.9nm. And the reflection factor at this time serves as 80% (0.8) grade with [drawing 23](#).

[0031] On the other hand, if 70nm or more of the Pt layers 4 is formed in the front face of the class 39 of a reflecting mirror 3, in order to be ruined to about 2nm, a reflection factor falls to about 40% with [drawing 23](#). In this way, the X-ray intensity on the exposure side 5 can realize the fixed reflecting mirror 3. Furthermore, a surface roughness can also be made to increase by thickening the Pt layer 4.

[0032] 3. [view 25](#) of the gestalt of operation is the block diagram of the X-ray catoptric system used as the gestalt of operation of the 3rd of this invention, and has given the same sign to the same configuration as [drawing 1](#). In 1 of the gestalt of operation, the phenomenon in which irradiate the ion 12, such as helium, Ne, inactive Ar, inactive Xe, etc., etc. on the front face of the Pt layer 4 with the gestalt of this operation, a front face is ruined with the sputtering effect, and a reflection factor falls as technique of reducing the reflection factor of a class 39 although the technique which does not form the Pt layer 4 was taken is used.

[0033] If the grain which had high energy in the matter is generally irradiated, a sputtering phenomenon will arise, a surface atom will start being struck, and irregularity will occur on the surface of the matter. Since the reflection factor of a class 39 falls by worsening the surface roughness of a class 39 by such sputtering, a uniform X-ray intensity distribution can be obtained on the exposure side 5.

[0034] With the gestalt of 4. book operation of the gestalt of operation, the layer which consists of these light elements is formed by irradiating the ion of the low light element of energy, for example, SiC, Si, aluminum, etc., instead of irradiating the ion which has high energy like 3 of the gestalt of operation as technique of reducing the reflection factor of a class 39. Since energy is low, layer formation of the spatter phenomenon can be produced and carried out.

[0035] When carrying out oblique incidence of the X-ray to the matter, in order to hardly invade into the matter, its very thin layer is enough as the reflective layer. For example, the reflection factor of Pt layer when an X-ray carries out incidence to Pt layer with 1.58 incident angles is shown in [drawing 26](#). In the case of Pt layer, it turns out that it reflects enough by 10nm. It is of the same grade also about the case of a light element. Then, if only 50nm of SiCs is formed in the front face of the class 39 of a reflecting mirror 3, the reflection factor of a class 39 will become the thing of SiC. Thereby, a uniform X-ray intensity distribution can be obtained on the exposure side 5.

[0036] 5. [view 27](#) of the gestalt of operation is the block diagram of the X-ray catoptric system used as the gestalt of operation of the 5th of this invention, and has given the same sign to the same configuration as [drawing 1](#). With the gestalt of this operation, the X-ray catoptric system for X-ray lithography is actually installed into a vacuum, the generator 6 which generates ion or a neutral particle is installed into the vacuum housing (un-illustrating) by which the reflecting mirror 3 is contained, and the ion or the neutral particle 12 of a metal or a light element is irradiated at the reflector of a reflecting mirror 3.

[0037] At this time, the position on-the-strength detection monitor 7 arranged in the exposure side 5 detects the X-ray intensity on the exposure side 5, ion or the neutral particle 12 is irradiated at the class (1-4 of the gestalt of operation class 39) of the reflecting mirror 3 with which the X-ray intensity on the exposure side 5 corresponds with a strong position, and the X-ray reflection factor of this class is attenuated.

[0038] The thickness of the matter (for example, Pt) which constitutes a reflective layer like 2 of the gestalt of operation as technique of attenuating a reflection factor by the ion or the neutral particle 12 irradiated from a generator 6 may be thickened, sputtering may be carried out like 3 of the gestalt of operation, and the matter with a low reflection factor may be formed like 4 of the gestalt of operation.

[0039] As explained using drawing 7, drawing 9, - view 20, while the relation between the intensity distribution of an X-ray and the reflecting point on a reflecting mirror 3 is calculated beforehand and the position on-the-strength detection monitor 7 detects an actual X-ray intensity distribution, the correction with a more high precision is attained by reducing the reflection factor of the class of the reflecting mirror 3 with which X-ray intensity corresponds with a strong position.

[0040] In addition, with the gestalt of the above operation, as an X-ray reflecting mirror 3, although a non-plane mirror with which the configuration is described by the formula (1) was used, it may not restrict to this and a plane mirror may be used.

[0041]

[Effect of the Invention] According to this invention, like, by [according to claim 1] establishing the field where the reflection factor of an X-ray is high, and the field where the reflection factor of an X-ray is low in the reflector of an X-ray reflecting mirror, the conventionally unescapable intensity distribution of an X-ray optics system can avoid the phenomenon which becomes uneven, and can offer the X-ray beam with fixed intensity distribution required for X-ray lithography. Consequently, since optical system required for X-ray lithography can be offered, it is enabled to mass-produce the overly detailed pattern of 0.1 micrometer class, and small super-LSI mass production of power consumption is attained at high speed. Moreover, it can also be used as illumination systems, such as various X-ray optics systems, for example, X-ray reduction optical system, and an X-ray microscope.

[0042] Moreover, X-ray intensity can be made uniform in an exposure field by making the field where the reflection factor of an X-ray is high into the field according to claim 2 in which the matter with the high reflection factor of an X-ray was formed like, making the field where the reflection factor of an X-ray is low into the field in which the matter with the low reflection factor of an X-ray was formed, and making the field of the X-ray reflecting mirror with which the X-ray intensity in an exposure field corresponds with a strong position into the field where an X-ray reflection factor is low. Moreover, the field in which the matter with the low reflection factor of the X-ray with which the reflection factor of an X-ray serves as a low field was formed is easily realizable by carrying out the mask of the applicable fraction and forming a reflective layer for example, at the time of a reflecting mirror manufacture.

[0043] Moreover, X-ray intensity can be made uniform in an exposure field by making the field of the X-ray reflecting mirror according to claim 3 with which a surface roughness makes a large field the field where the reflection factor of an X-ray is low by a surface roughness making a parvus field the field where the reflection factor of an X-ray is high like, and the X-ray intensity in an exposure field corresponds with a strong position into the field where an X-ray reflection factor is low. Moreover, the field where the surface roughness from which the reflection factor of an X-ray serves as a low field is large is easily realizable by irradiating ion after a reflecting mirror manufacture at an applicable fraction, or forming the layer which consists of a light element.

[0044] Moreover, detecting an X-ray intensity distribution of an exposure side with a position on-the-strength detection means like by [according to claim 4] forming an X-ray reflecting mirror, a position on-the-strength detection means, and a generator, the X-ray intensity on an exposure side can reduce the X-ray reflection factor of the reflective field of the X-ray reflecting mirror which corresponds with a strong position by irradiation of ion or a neutral particle, and can perform the correction with a more high precision.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the block diagram of the X-ray catoptric system used as the gestalt of operation of the 1st of this invention.

[Drawing 2] It is drawing showing the relation between the incident angle of an X-ray, and a reflection factor.

[Drawing 3] It is drawing showing the relation between the incident angle of an X-ray, and a reflection factor.

[Drawing 4] It is drawing showing the configuration of SR light source.

[Drawing 5] It is drawing showing the intersection of the X-ray and reflecting mirror which were emitted from the light source.

[Drawing 6] It is drawing showing the intersection of an X-ray and an exposure side.

[Drawing 7] It is drawing showing the X-ray intensity distribution which integrated with the of-condensation-and-rarefaction distribution and of-condensation-and-rarefaction distribution of an X-ray on an exposure side to z shaft orientations.

[Drawing 8] It is drawing showing the example which divided the reflecting mirror front face into 13 fields.

[Drawing 9] It is drawing showing the of-condensation-and-rarefaction distribution on the exposure side of the X-ray reflected from the class 31 of a reflecting mirror.

[Drawing 10] It is drawing showing the X-ray intensity distribution which integrated with the of-condensation-and-rarefaction distribution and of-condensation-and-rarefaction distribution on the exposure side of the X-ray reflected from the class 32 of a reflecting mirror to z shaft orientations.

[Drawing 11] It is drawing showing the X-ray intensity distribution which integrated with the of-condensation-and-rarefaction distribution and of-condensation-and-rarefaction distribution on the exposure side of the X-ray reflected from the class 33 of a reflecting mirror to z shaft orientations.

[Drawing 12] It is drawing showing the X-ray intensity distribution which integrated with the of-condensation-and-rarefaction distribution and of-condensation-and-rarefaction distribution on the exposure side of the X-ray reflected from the class 34 of a reflecting mirror to z shaft orientations.

[Drawing 13] It is drawing showing the X-ray intensity distribution which integrated with the of-condensation-and-rarefaction distribution and of-condensation-and-rarefaction distribution on the exposure side of the X-ray reflected from the class 35 of a reflecting mirror to z shaft orientations.

[Drawing 14] It is drawing showing the X-ray intensity distribution which integrated with the of-condensation-and-rarefaction distribution and of-condensation-and-rarefaction distribution on the exposure side of the X-ray reflected from the class 36 of a reflecting mirror to z shaft orientations.

[Drawing 15] It is drawing showing the X-ray intensity distribution which integrated with the of-condensation-and-rarefaction distribution and of-condensation-and-rarefaction distribution on the exposure side of the X-ray reflected from the class 37 of a reflecting mirror to z shaft orientations.

[Drawing 16] It is drawing showing the X-ray intensity distribution which integrated with the of-condensation-and-rarefaction distribution and of-condensation-and-rarefaction distribution on the

exposure side of the X-ray reflected from the class 38 of a reflecting mirror to z shaft orientations.

[Drawing 17] It is drawing showing the X-ray intensity distribution which integrated with the of-condensation-and-rarefaction distribution and of-condensation-and-rarefaction distribution on the exposure side of the X-ray reflected from the class 39 of a reflecting mirror to z shaft orientations.

[Drawing 18] It is drawing showing the X-ray intensity distribution which integrated with the of-condensation-and-rarefaction distribution and of-condensation-and-rarefaction distribution on the exposure side of the X-ray reflected from the class 40 of a reflecting mirror to z shaft orientations.

[Drawing 19] It is drawing showing the X-ray intensity distribution which integrated with the of-condensation-and-rarefaction distribution and of-condensation-and-rarefaction distribution on the exposure side of the X-ray reflected from the class 41 of a reflecting mirror to z shaft orientations.

[Drawing 20] It is drawing showing the X-ray intensity distribution which integrated with the of-condensation-and-rarefaction distribution and of-condensation-and-rarefaction distribution on the exposure side of the X-ray reflected from the class 42 of a reflecting mirror to z shaft orientations.

[Drawing 21] It is drawing showing the intersection of the X-ray at the time of exposing SiC in the class 39 of a reflecting mirror, and a reflecting mirror.

[Drawing 22] It is drawing showing an X-ray intensity distribution of the whole exposure side at the time of exposing SiC in the class 39 of a reflecting mirror.

[Drawing 23] It is drawing showing the relation between the surface roughness of the reflector to an X-ray with an incident angles of 1.58 and a wavelength of 0.7nm, and the reflection factor of an X-ray.

[Drawing 24] It is drawing showing the relation between the thickness of Pt layer, and the surface roughness of Pt layer.

[Drawing 25] It is the block diagram of the X-ray catoptric system used as the gestalt of operation of the 3rd of this invention.

[Drawing 26] It is drawing showing the relation between the thickness of Pt layer, and the reflection factor of an X-ray.

[Drawing 27] It is the block diagram of the X-ray catoptric system used as the gestalt of operation of the 5th of this invention.

[Description of Notations]

1 [-- An X-ray reflecting mirror, 4 / -- Pt layer, 5 / -- An exposure side, 6 / -- A generator, 7 / -- Position on-the-strength detection monitor.] -- The light source, 2 -- An X-ray, 3

[Translation done.]

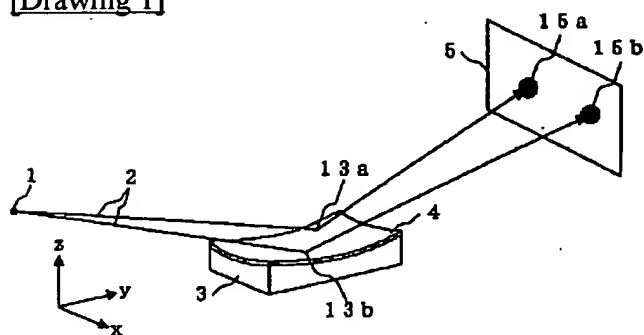
* NOTICES *

The Japanese Patent Office is not responsible for any damages caused by the use of this translation.

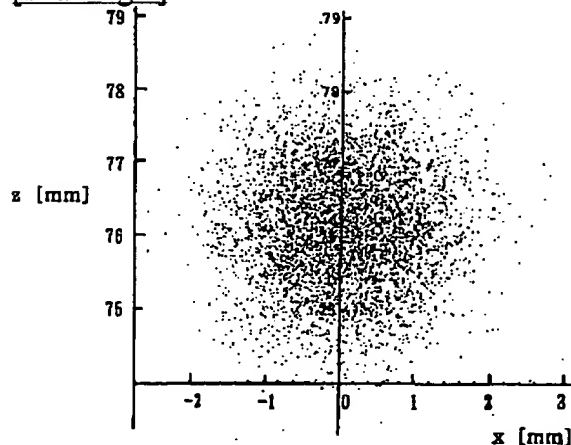
1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3. In the drawings, any words are not translated.

DRAWINGS

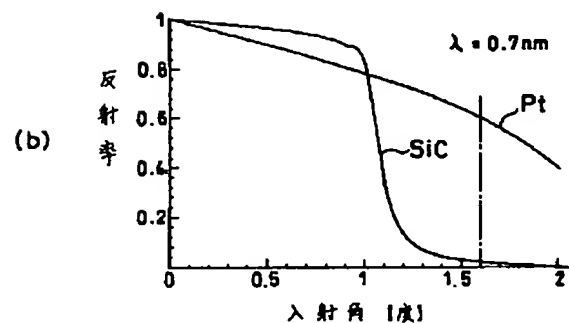
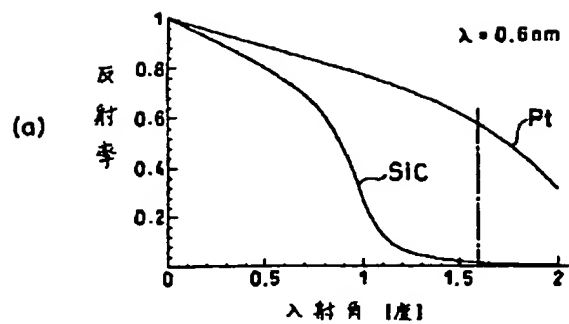
[Drawing 1]



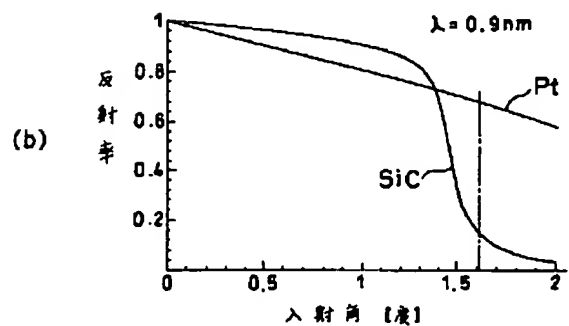
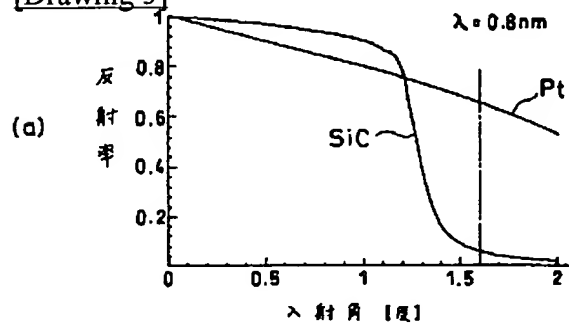
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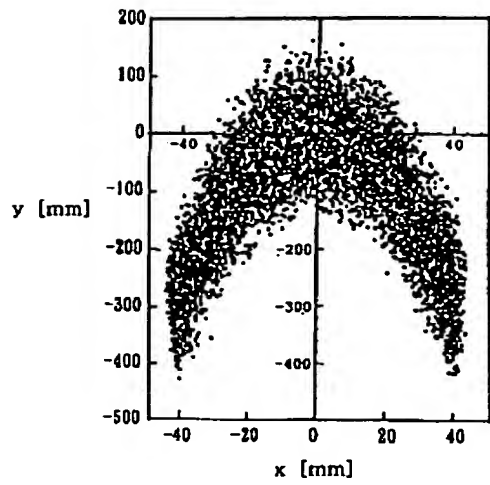
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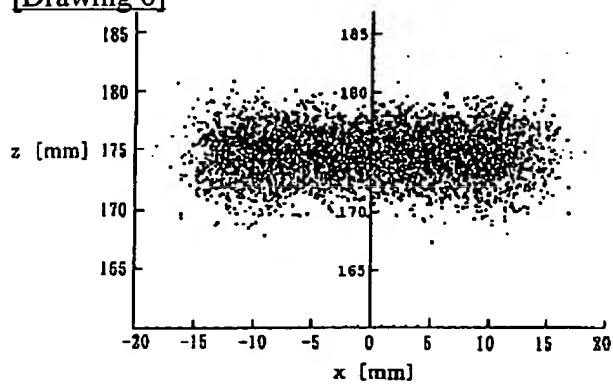
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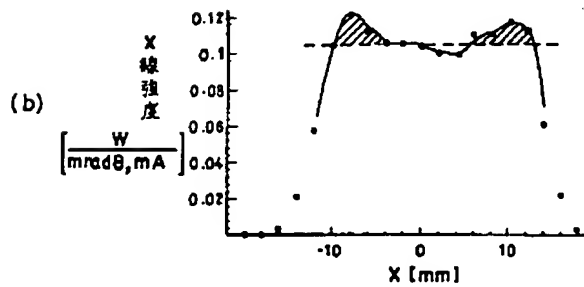
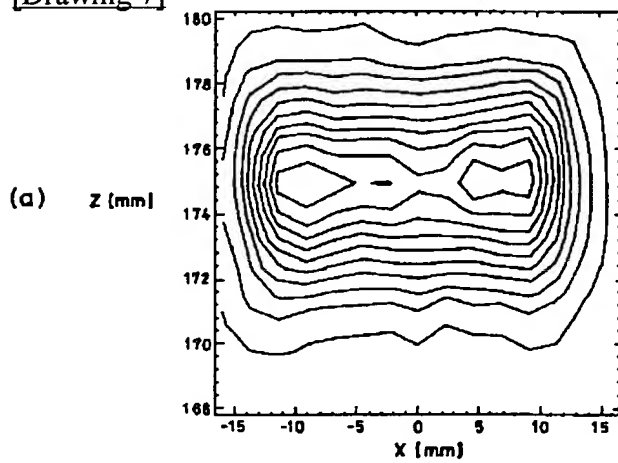
[Drawing 5]



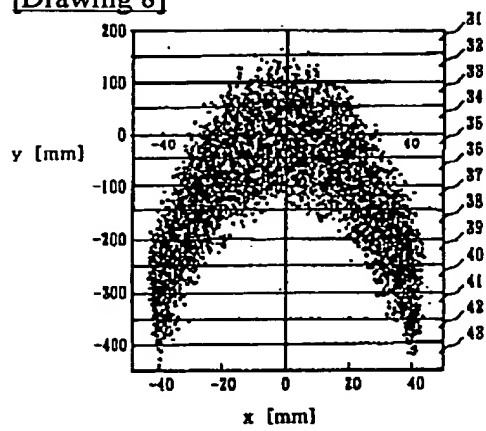
[Drawing 6]



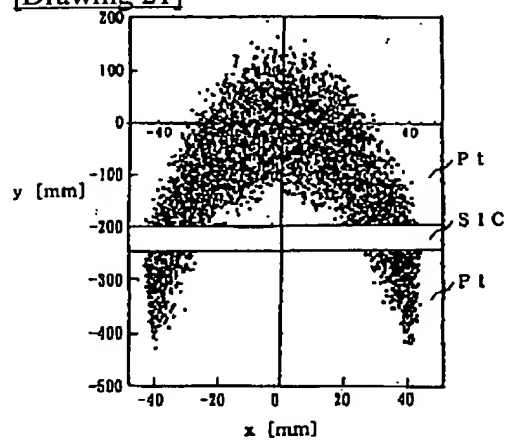
[Drawing 7]



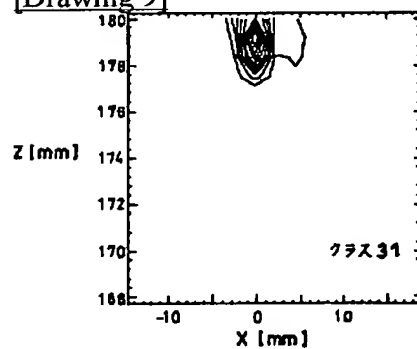
[Drawing 8]



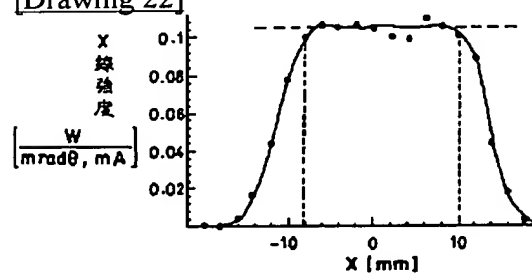
[Drawing 21]



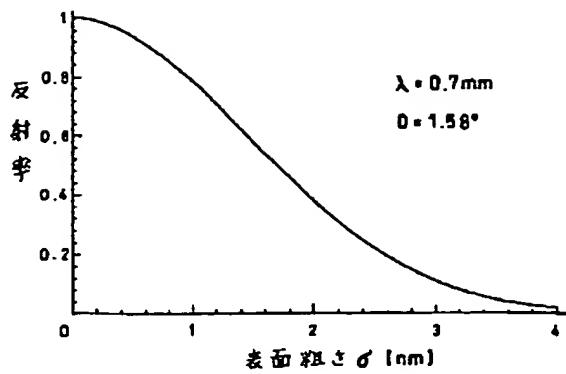
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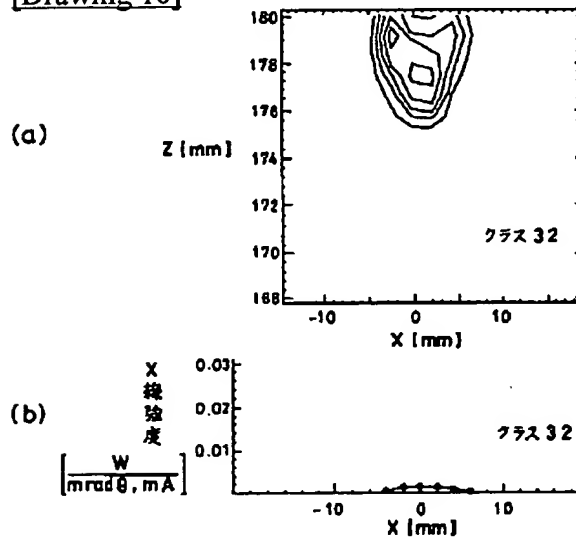
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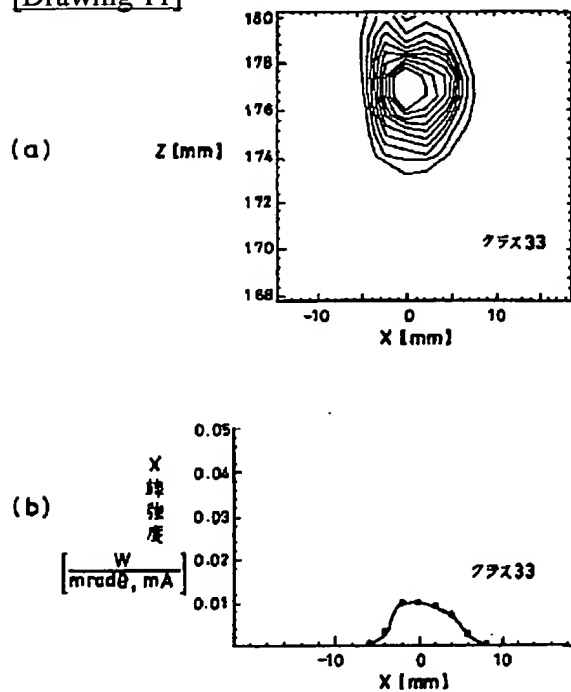
[Drawing 23]



[Drawing 10]



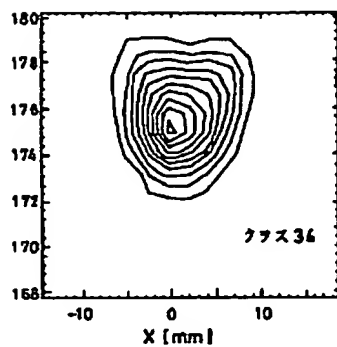
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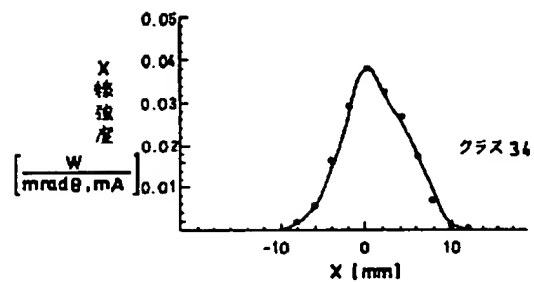
[Drawing 12]

(a)

Z [mm]

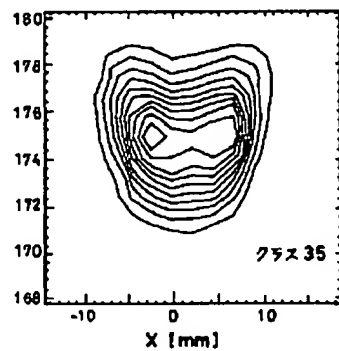


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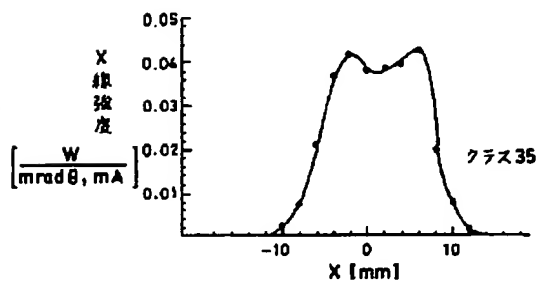
[Drawing 13]

(a)

Z [mm]

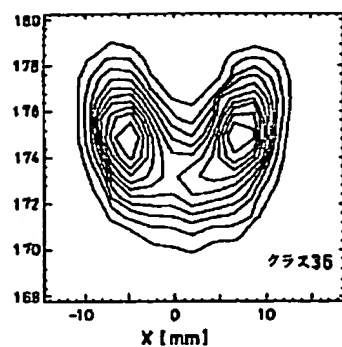


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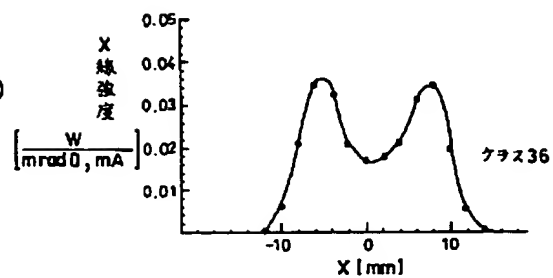
[Drawing 14]

(a)

Z [mm]



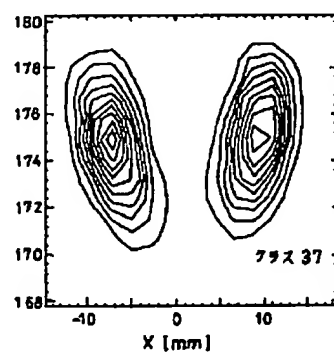
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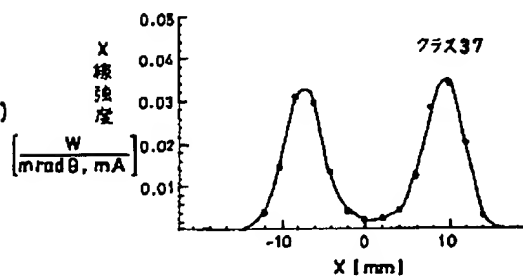
[Drawing 15]

(a)

Z [mm]

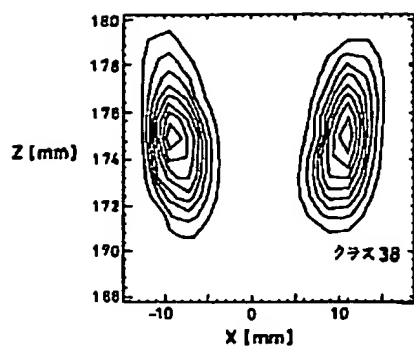


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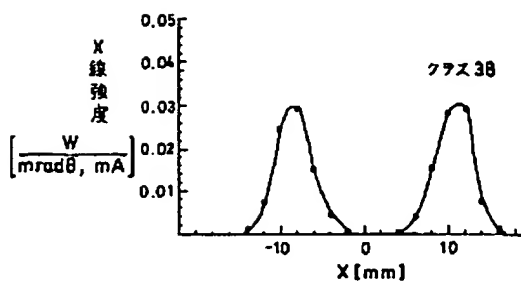


[Drawing 16]

(a)

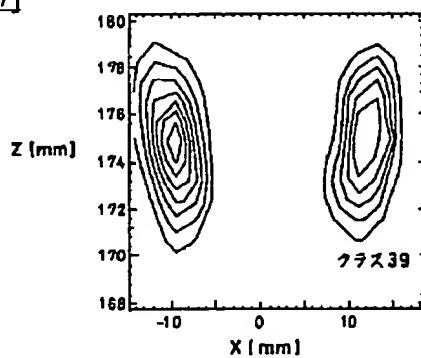


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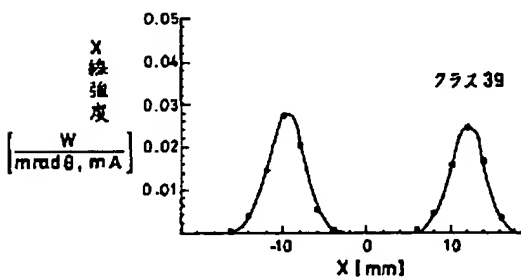


[Drawing 17]

(a)

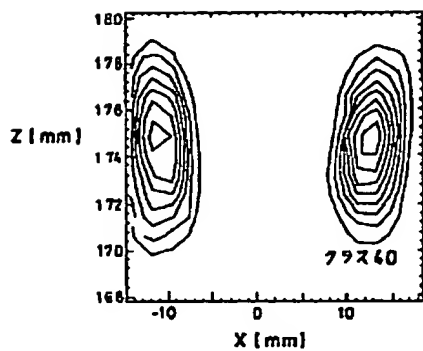


(b)

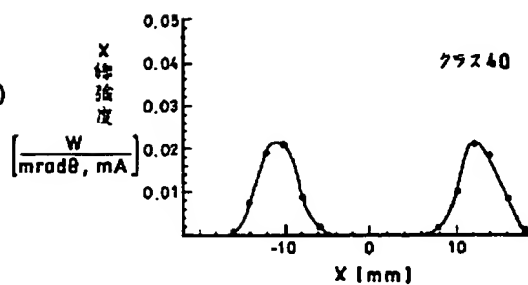


[Drawing 18]

(a)

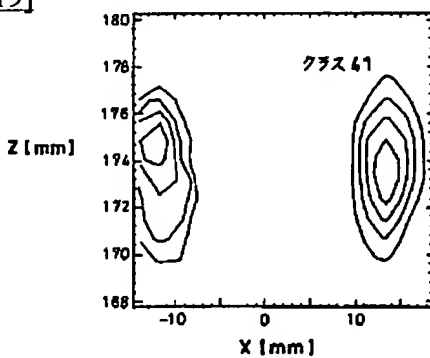


(b)

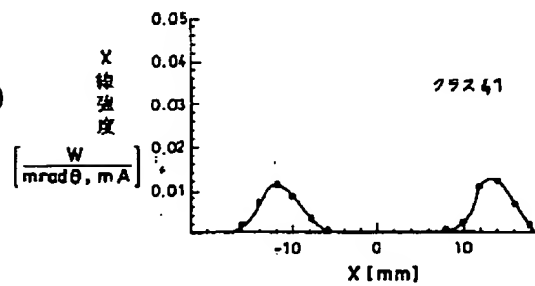


[Drawing 19]

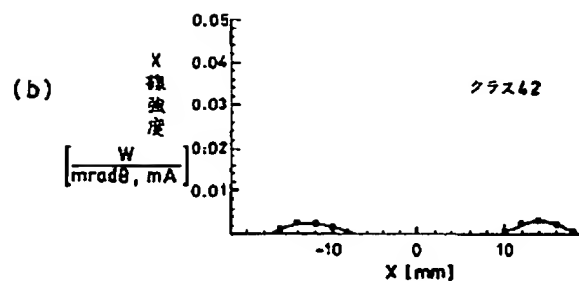
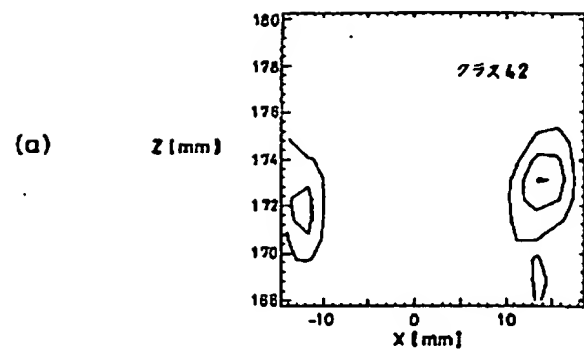
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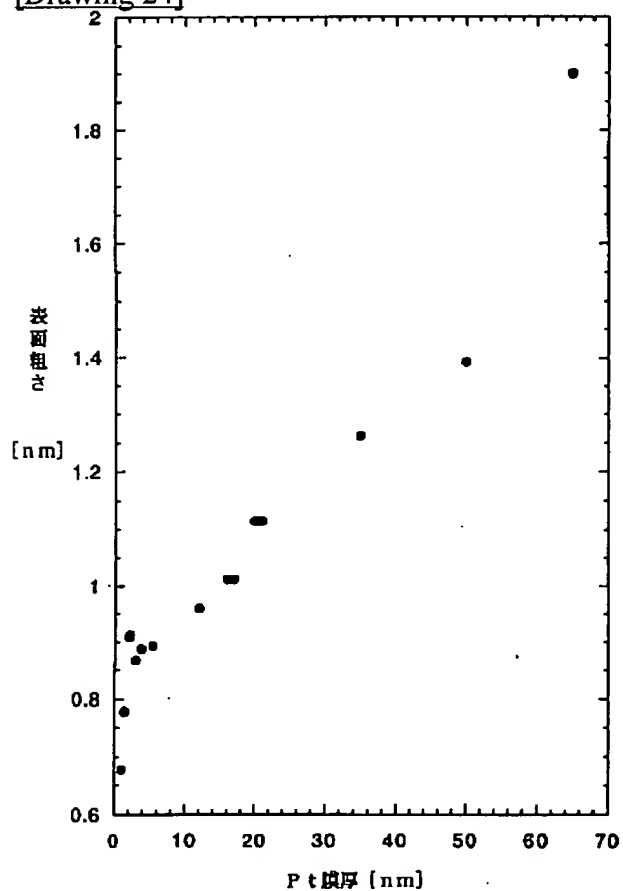
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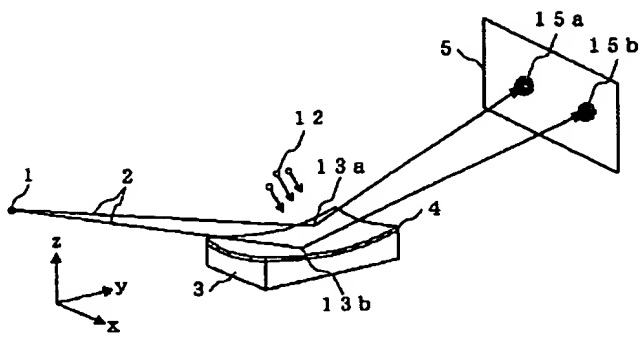
[Drawing 20]



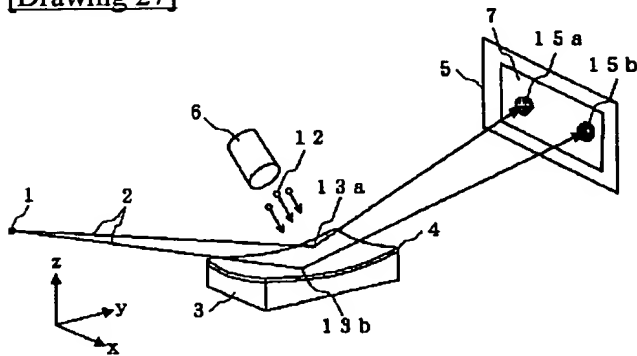
[Drawing 24]



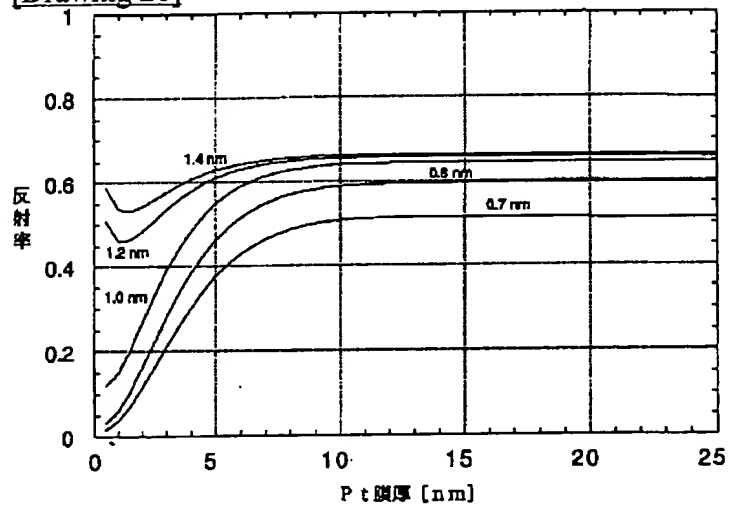
[Drawing 25]



[Drawing 27]



[Drawing 26]



[Translation done.]